

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by the Wilson Ornithological Society

VOL. 98, No. 4

DECEMBER 1986

PAGES 505–664

Wilson Bull., 98(4), 1986, pp. 505–515

OBSERVATIONS ON THE ECOLOGY AND BEHAVIOR OF THE PALE-BILLED SICKLEBILL

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ABSTRACT.—We studied the ecology and behavior of the Pale-billed Sicklebill (*Epimachus bruijnii*) in northwestern Papua New Guinea. Vocal adult males defended small foraging territories. Boundary disputes involved counter-singing, chases, and displays by one male to the other. Movements of a focal male averaged 2 km/day. A 7-day range of this male covered 15 ha. We recorded the species consuming 7 species of food plants from at least 5 botanical families. Insect-foraging included use of the decurved bill for probing knotholes. Diet and mating behavior appeared to conform to that of typical polygynous birds of paradise. Evidence is presented indicating that this species inhabits the Sepik drainage, southeast of where the bird had been recorded previously. *Received 24 Sept. 1985, accepted 1 May 1986.*

The Pale-billed Sicklebill (*Epimachus* [*Drepanornis*] *bruijnii*) is arguably the least known of the birds of paradise (Paradisaeidae), and until recently it has been known in life from only a few brief observations (Ripley 1964, Gilliard 1969, Diamond 1981, Whitney 1986, B. W. Finch, in litt.). Sometimes called the White-billed or Lowland Sickle-billed Bird of Paradise (Gilliard 1969, Diamond 1981), the species is poorly known for three reasons: (1) it has a small geographic range confined to a little-explored region, (2) it is wary, and (3) it spends much of each day in the canopy vegetation of the interior of tall rainforest. Of the 4 species of *Epimachus* sicklebills, the Pale-billed is the only lowland-dwelling form, and until very recently was believed to occur only in Irian Jaya—the Indonesian province of western New Guinea (Cooper and Forshaw 1977, see Diamond et al. 1977, Diamond 1981, Whitney 1986).

The Pale-billed Sicklebill is a member of a morphologically anomalous genus, one of whose member species exhibits an insectivorous diet in

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combination with polygynous behavior. Here, we (1) present information on sexual organization, use of space, diet and foraging, and courtship display; and (2) compare this species' behavior with that of other members of this remarkable family.

STUDY AREAS

Between 14 July and 10 August 1984 we studied the Pale-billed Sicklebill at 3 sites in the lowlands of the West Sepik Province, northwesternmost Papua New Guinea. From 14 to 29 July, we worked at an alluvial forest site (Puwani) on the west bank of the Puwani River, 6 km SSE of the Bewani Patrol Post, 45 km from the coast ($3^{\circ}1'S$, $141^{\circ}10'E$, 195 m elevation). The site was a large, undisturbed tract of flat, tall rainforest, with large-boled trees and a very high (ca 40 m) canopy.

We also observed the sicklebill for short periods on 3 days between 30 July and 4 August along the road southeast of Vanimo High School, ca 7 km SE of Vanimo town. Following this, we made a forest camp on the track to Krisa village, at a point ca 8.5 km SE of Vanimo, in low limestone hills. At this site ($2^{\circ}47'S$, $141^{\circ}20'E$, 210 m), we studied the sicklebill in forest that differed markedly from that at Puwani in being lower-statured, with an irregular canopy and smaller-boled trees. The topography was quite rough, and the entire region was heavily dissected by small streams.

METHODS

In order to observe and monitor activities of sicklebills at the Puwani and Krisa sites, we cut and strung ca 5 km of survey lines through forest inhabited by sicklebills, using the methods described in Beehler and Pruett-Jones (1983). Each transect was marked by a colored plastic line. When a specific observation was made from a transect, the line at this point was tagged with masking tape and the tag numbered. In this fashion the movements and calling posts of individual sicklebills could be mapped accurately using the data from a final field survey of the transect and marker points.

At first we sought to locate individual sicklebills within walking range of the camps. We then cut transect lines around vocal and active males. After following an individual male for several days, it was possible to begin predicting his daily use of space, and efforts were made to study details of diet, foraging behavior, and male courtship habits. Attempts to net sicklebills failed.

Vocal playback experiments were conducted at Puwani to measure male response to an apparent male intruder. The songs of a male recorded from Vanimo by Bret Whitney were played from a remote speaker 2.5 m high in a sapling in the forest. Playbacks were conducted within earshot of an active and vocal male. Songs were played at intervals typical for the species. Playbacks were attempted at both edge and center of a male's home range.

Additional data were obtained from notes on stomach contents made by field collectors. These were solicited from museums known to hold collections of birds from western New Guinea. A review of papers discussing this species provided no data on diet (cf. Diamond 1981).

Nomenclature follows Diamond (1972) and Beehler and Finch (1985).

RESULTS

Habitat selection.—In the lowlands of the West Sepik Province, the Pale-billed Sicklebill is sparsely distributed through nearly all forested

habitats. It was vocal and common along the road in selectively logged hilly lowland forest within a kilometer of the coast as well as in the coastal limestone hills to more than 200 m elevation at the Krisa camp. It occurred at a lower density in the flat Puwani basin that lies between the Bewani Mountains to the south and the coastal limestone hills to the north. No birds were observed in either coastal mangroves or regenerating second growth, although we spent only brief periods in these habitats. The Pale-billed Sickiebill appears to prefer old forest with at least some large canopy trees, but will occasionally use selectively logged forest and forest edge. We could detect no special habitat requirements. It appears to be a forest canopy-dweller like its congeners.

Diet and foraging.—We made 17 observations of foraging sickiebills. These are supplemented by two stomach samples from specimens in the Museum Zoologicum Bogoriense, Bogor, Indonesia. Twelve document fruit-eating, and 7 are of insect-foraging. Frugivory by this sickiebill includes at least 7 plant species from 5 families, and these include: *Cyrtostachys* sp. (Palmae), cf. *Syndapsis* sp. (Araceae), *Ficus* sp. (Moraceae), *Sloanea* cf. *forbesii* (Elaeocarpaceae), and an unidentified fruit of a red liana.

One sickiebill took at least one of the specialized, arillate and capsular species that can be classified as a “bird of paradise fruit”—the *Sloanea* (cf. Beehler 1983b). A single territorial male was observed visiting the same large *Sloanea* on 3 days at Puwani. On 25 July this male sat in the fruiting *Sloanea* for more than 30 min, during which time it regurgitated more than 33 small seeds from an unidentified plant (none was *Sloanea*).

An understory arecoid palm with large loads of small fruit (cf. *Cyrtostachys*, see Essig 1977) was a common food plant at the Krisa site. We observed the sickiebill clambering head down onto the lax, heavily laden rachillae of this palm to take fruits. The palm was one of the more common plants in the forest at Krisa (more than 10 plants/ha), and we observed it being visited by the Lesser Bird of Paradise (*Paradisaea minor*) and the Twelve-wired Bird of Paradise (*Seleucidis melanoleuca*).

Insect-foraging habits were similar to those recorded for the Buff-tailed Sickiebill (*Epimachus albertisi*; Beehler 1983a, unpubl. data). The species was cryptic and wary, and feeding observations were difficult to obtain. Seven observations of insectivory were of birds probing into knotholes and worm holes in dead wood, 3 were of birds searching dead leaves, and 2 were of birds searching vertical or sloping bark or limb surfaces. This sickiebill did not chisel or hammer with its beak, a method commonly employed by the shorter-billed paradisaeine genera such as *Lophorina*, *Ptiloris*, and *Paradisaea* (Beehler 1985).

Mixed species flocks.—In his single observation of a Pale-billed Sick-

lebill in northern Irian Jaya, Diamond (1981) noted that the female-plumaged bird was part of a mixed-species flock that included the Rufous Babbler (*Pomatostomus isidorei*) and Rusty Pitohui (*Pitohui ferrugineus*). We saw sicklebills in mixed flocks 5 times (Table 1). In these foraging aggregations it was not uncommon to find 4 species of birds of paradise moving through the understory together, searching for fruit and insects. At Puwani, the flocks we observed often lacked birds of paradise and were dominated by numbers of smaller flocking insectivores (cf. Bell 1967). At Krisa, the birds of paradise were more numerous, more gregarious, and they appeared to join together into foraging flocks each day in the late morning and late afternoon.

On 3 occasions it appeared that the repeated call of the male sicklebill stimulated flock coalescence at the Krisa site. The sicklebill would call from a point in the forest middle story for a number of minutes, and males of the Magnificent Riflebird (*Ptiloris magnificus*) and Twelve-wired Bird of Paradise could be heard to call from sites progressively closer to the sicklebill, until the birds were all moving together in a foraging flock. At Krisa we found plumed males of these 3 species foraging in the understory at the same cluster of ripe fruit. From repeated daily observations of these male birds of paradise together at Krisa, it appears that they formed a regular daily association. Flocks at Krisa were unusual for another reason. The main components of these flocks—adult male birds of paradise—spent much of their time foraging for fruit.

Male movements and home range. — At the Puwani site we mapped the movements of a single adult male during 7 days (Fig. 1). This was possible to do without either radio-telemetry or color-marking because of the nature of the male's activities and because of the absence of other adult males from the home range of the focal bird. At Puwani, ranges of singing males were widely spaced and nonoverlapping. Our focal male ("male A") moved sluggishly over his exclusive home range in tall alluvial forest. We were able to monitor his movements because he called with considerable frequency and regularity (see following sections). During our observation period (19–28 July), the male remained within a 15-ha patch of undisturbed forest. We never heard or saw another male-plumaged bird in this range. We did not encounter vocal neighboring males within 150 m of the edge of this "territory."

Male A traveled ca 2 km/day in his small home range (Fig. 1). Major foraging flights averaged ca 100 m ($N = 118$, range = 20–300 m), and the male spent an average of 14 min/perch site ($N = 120$, range = 1–46 min). He often remained more than 30 min in a single tree, singing periodically.

At the Krisa site we focused on intermale dispersion and male boundary maintenance. Sicklebills seemed in greater abundance at this latter camp,

and intermale distance appeared reduced. Our focal male at Krisa (male B) held a territory that included our campsite, and as a result he was always within easy earshot. A neighbor male (male C) inhabited an abutting territory ENE of that of male B. In the late afternoon on 3 days, these 2 males confronted each other at what perhaps was a territorial boundary. A summary of the encounter on 7 August is typical: Initially, while perched more than 50 m apart, the birds counter-called for 7 min. Male B made short flights through the middle story. Then male C entered the range of male B and came to perch on the same branch as B. One bird displayed to the other, and the latter departed. They met again in another tree and began a cycle of visits and departures in which the actors apparently reversed roles. Periodically, the vocal activity waxed and waned. After 68 min the encounter ended with the 2 males retreating from each other.

We conducted vocal playback experiments with male A at the Puwani site on 5 occasions over 3 days, and once with a male near Vanimu High School. In 2 instances at Puwani, male A came to the site of the playback, in a single instance male A called more frequently but did not approach, and on 2 instances male A became silent and gave no evidence of approach. The male at the second site responded vocally but did not approach.

Male vocalizations.—As with the other sicklebills, vocalizations are important to the behavioral repertoire of the male Pale-billed Sicklebill. On 4 clear mornings the first songs of male B were given between 06:31 and 06:36. Calling frequency was highest in the half-hour 06:30–07:00, when the male delivered, on average, 1.15 advertisement songs/min ($N = 81$). This rate continued slightly in excess of 1 call/min until after 08:00, when it dropped to 0.8/min. Between 09:00 and 15:30 h, the male sang between 2 and 10 songs/h. Later in the afternoon calling frequency rose to slightly less than that recorded in the early morning.

The advertisement song of the male Pale-billed Sicklebill is distinct from those of the other 3 species of *Epimachus*. It is a string of hoarse or hollow whistled notes, sometimes preceded or ended by one or several low musical gurgles or coughs, e.g., *wik-kew KWEER KWEER kwer? kor kor kor* (we recorded considerable variation within and between individuals). It is moderately high-pitched, carries a considerable distance, and is sometimes suggestive of certain vocalizations of the Lesser Bird of Paradise (Whitney 1986) or the western population of the Magnificent Riflebird (cf. Ripley 1964). The main body of this song is a series of 4–6 plaintive, musical notes that either rise or fall sharply in pitch. In some instances the first few notes are upslurred and the final few are downslurred. The main portion of the song is often appended with soft or gurgled notes, usually at a lower pitch.

TABLE 1
COMPOSITION OF MIXED FLOCKS THAT INCLUDED PALE-BILLED SICKLEBILL

Species ^a	Puwani		Krisa		
	25 July 10:30 h	5 Aug. 12:10 h	6 Aug. 09:15 h	6 Aug. 15:45 h	7 Aug. 15:00 h
Pale-billed Sicklebill (<i>Epimachus bruynii</i>)	1 ♂, 1 FP ^b	1 ♂, 1 FP	1 ♂	1 ♂	1 ♂ (B), 1 ♂ (C) ^c
Twelve-wired Bird of Paradise (<i>Seleucidis melanoleuca</i>)	1 ♀, 1 FP ♂	1 ♂	1 ♂, 1 FP	1 ♂, 1 FP	1 ♂, 1 FP
Magnificent Riflebird (<i>Ptiloris magnificus</i>)		1 ♂, 1 FP	1 ♂		1 ♂
Lesser Bird of Paradise (<i>Paradisaea minor</i>)		1 FP		1 FP	1 FP
Jobi Manucode (<i>Manucodia jobiensis</i>)	1			3	
Spangled Drongo (<i>Dicrurus hottentottus</i>)	1	1	1		
Rufous Babbler (<i>Pomatostomus isidorei</i>)	4+		3+		
Variable Pitohui (<i>Pitohui kirhocephalus</i>)		3+	4+		
Rusty Pitohui (<i>Pitohui ferrugineus</i>)	5+				
King Bird of Paradise (<i>Cicinnurus regius</i>)			1 FP		
Golden Monarch (<i>Monarcha chrysomela</i>)		1			

TABLE 1
CONTINUED

Species ^a	Puwani		Krisa		
	25 July 10:30 h	5 Aug. 12:10 h	6 Aug. 09:15 h	6 Aug. 15:45 h	7 Aug. 15:00 h
Rufous-backed Fantail (<i>Rhipidura rufidorsa</i>)					
Olive Flycatcher		1			
(<i>Microeca flavovirescens</i>)		1			
White-eared Catbird					
(<i>Ailuroedus buccoides</i>)			1		

^a English and scientific nomenclature follows Beehler and Finch (1985).
^b FP = female-plumaged bird, undetermined as to sex, unless indicated.
^c Two adult males appeared in the same flock at what apparently was a territorial boundary.

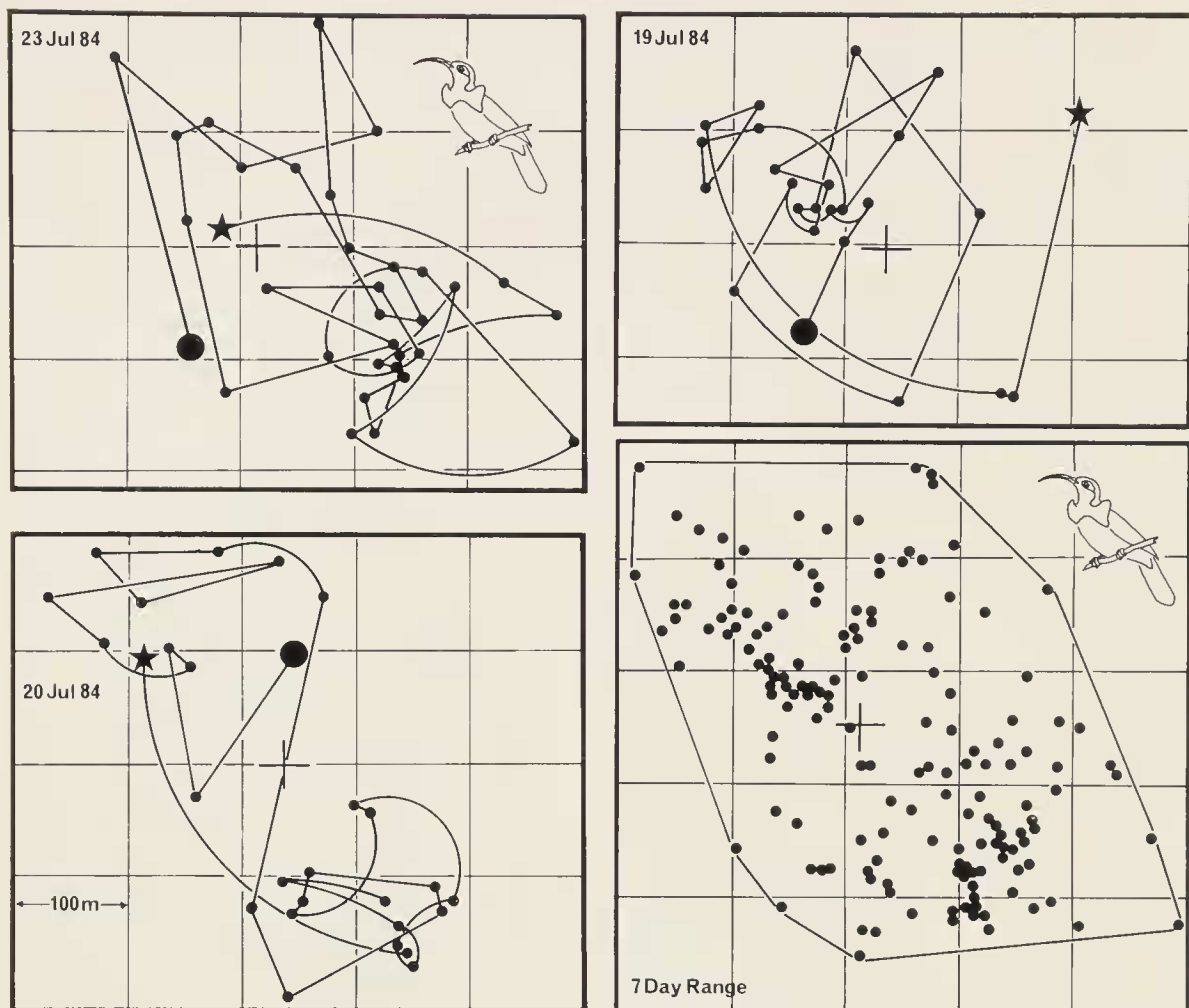


FIG. 1. Daily movements and 7-day home range of male A at Puwani. Three sample days of male movements are illustrated. The grid is 100 × 100 m. Large black circle indicates position of bird at beginning of day (not necessarily its roosting place).

Length of the advertisement song averaged 5.2 sec ($N = 27$, range = 3.7–7 sec); the median number of notes per call was 8 ($N = 27$, range = 5–10). The male sicklebill gave virtually no other call aside from this one. On occasion, while foraging, the male gave a quiet interrogative note, *wehn?*—very similar to those given by a number of the typical birds of paradise.

Mating system.—Unlike most avian families, the dominant mating system for the Paradisaeidae is polygynous court display (Beehler and Pruett-Jones 1983), and monogamous systems are known for only 4 of the 42 species. The Pale-billed Sicklebill exhibits none of the following characters exhibited by known monogamous birds of paradise: (1) paired foraging movements, (2) plumage monomorphism, (3) drab male coloration, or (4) active vocalization by the female. On the other hand, this sicklebill does show characters associated with polygynous birds of paradise: (1) considerable plumage dimorphism between the sexes, (2) male

erectile pectoral plumes, (3) elaborate posturing display by the male, (4) no significant vocalizations by the female, and (5) male foraging movements unassociated with females (Rand 1938, 1940; Beehler 1983c, 1985).

The Pale-billed Sicklebills has an activity pattern similar to that of the Buff-tailed Sicklebills as well as to that of the Superb Bird of Paradise (*Lophorina superba*) (Beehler and Pruett-Jones 1983). The male patrols his territory daily, displaying at different points and calling frequently, presumably to defend it from rival males, as well as to attract potential mates. Male-female bonding appears to be minimal, and it may be limited to mating. We have no information on nesting and nest care.

Male display behavior.—We did not observe full courtship or mating by the sicklebill. Once, at Krisa, we encountered a male displaying repeatedly in the cover of thick viny vegetation in the middle story of the forest interior. The male was attended by a female-plumaged individual, but we were unable to watch clearly either bird during the interaction that lasted several minutes. We encountered male display under 3 circumstances: (1) when the male was visited by a presumed female, (2) in the absence of conspecifics (a behavior common among other polygynous birds of paradise including the Buff-tailed Sicklebills) (Beehler 1983a), and (3) during male-male territorial encounters. In all 3 instances the male displayed in the lower middle story (ca 7–10 m) of the forest interior while perched on a small horizontal branch.

Display is preceded by delivery of the advertisement call, but the male gives no vocalizations while displaying. The high point of the display, however, is signaled by rapid rattling of the bill for a number of seconds.

On 5 occasions we observed a single stereotyped posturing display by the focal male (Frontispiece). The male perches upright on a branch, with his short upper pectoral plumes erected vertically, the longer, lower breast feather puffed outward into a wide skirt, and the tail fanned. The male holds this position with little movement (except for rattling bill) for as long as 10 sec. This upright posture is quite unlike the inverted display of the Buff-tailed Sicklebills, yet is quite similar to that of the Brown Sicklebills (*Epimachus meyeri*) (Crandall 1946).

Female activities.—Although the male is vocal and predictable, and hence conspicuous, the female appears practically nonexistent to the field worker. The female's unprepossessing plumage and silence make her nearly impossible to find without radio-tagging. This is also the case with the female Buff-tailed Sicklebills (Beehler, unpubl. data).

DISCUSSION

In spite of its rather unusual appearance, in all other respects, the Pale-billed Sicklebills appears to be a typical bird of paradise. Our preliminary observations indicate the species has the type of court-based, polygynous

mating system that is known or strongly suspected for at least 34 of the birds of paradise (Beehler and Pruett-Jones 1983). Like most of the typical paradisaeid species, the Pale-billed Sicklebills has a diet that includes significant proportions of fruit and insects (see Schodde 1976, Beehler 1983b), and thus this bird differs from its presumed closest relative, the Buff-tailed Sicklebills, whose diet includes little fruit (Beehler 1983a, unpubl. data).

One characteristic of the genus *Epimachus* is the long decurved bill. At least two of the species (*albertisi* and *bruijnii*) use this bill for specialized knothole probing that is presently unknown in any other Papuan species.

Two species of sicklebill appear to be predominantly frugivorous (*bruijnii* and *fastuosus*), while the other pair (*meyeri* and *albertisi*) are predominantly insectivorous (Gilliard 1969, Schodde 1976, Beehler and Pruett-Jones 1983). The 2 frugivores exhibit bills that are measurably broader and less decurved than those of the 2 insectivores. The dichotomy does not follow present subgeneric lines; the 2 short-tailed sicklebills are presently placed in the subgenus *Drepanornis* (cf. Diamond 1972, Schodde 1976) while the 2 long-tailed species are considered true *Epimachus* (Gilliard 1969).

Whereas most birds of paradise are montane, the Pale-billed Sicklebills is lowland-dwelling. And, although other sicklebills show relatively large geographic distributions, the Pale-billed has a very small range, confined to the northern lowlands of western New Guinea (cf. Diamond 1981). In 1983 Bret Whitney recorded this species for the first time from Papua New Guinea. In his paper, Whitney (1986) supposed that the bird's range may be more extensive than previously recognized. In our field study we obtained indirect evidence that this sicklebill occurs in the vast Sepik drainage, to the south and east of where the bird has been recorded. Our chief field assistant, Simon Nako, knew the bird by its song and easily led us to the species when we first arrived in the area. He told us that he came to know the species while growing up at his village (Utai) in the western Sepik drainage, on the southern side of the Bewani Mountains. If the Pale-billed Sicklebills is widespread in the Sepik drainage, that it has been overlooked is not surprising. Unless one knows its voice, the bird is very difficult to observe. It has been overlooked by experienced naturalists who have spent considerable periods in the field where the bird occurs. If this sicklebill occurs, undetected, through large parts of the Sepik (New Guinea's third largest river system), one must consider that vast rainforest region in need of additional ornithological exploration.

ACKNOWLEDGMENTS

We thank A. Balo, S. Nako, P. Nano, and J. Wano for able assistance in the field. Fieldwork in the West Sepik Province of Papua New Guinea was made possible through permission

of the West Sepik Provincial Government, Wildlife Division of the Office of Environment and Conservation, Institute for Papua New Guinea Studies, and Wau Ecology Institute. The research was supported by the Smithsonian Institution, and we thank S. D. Ripley for his advice and encouragement. A. Safford, B. Finch, S. Devlin, C. Paisley, and P. Kaestner provided essential aid while in PNG. We thank G. Mees, S. A. Parker, M. K. LeCroy, W. Boles, D. W. Snow, J. I. Menzies, and S. Adisoemarto for information on their holdings of sicklebill specimens in their museums.

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